ECOLOGY OF MISSOURI FORESTS

Conservation Education Series

A Program of the Missouri Department of Conservation

The Missouri Department of Conservation

The Conservation Commission is by law the head of the Department of Conservation, which is responsible for the control, management, restoration and conservation of all fish, forest and wildlife resources of Missouri. The Commission appoints the Director, sets Department policy and approves budgets, regulations and real estate transactions.

The Department was created by an amendment to the Missouri State Constitution. The four Commissioners are appointed by the Governor of the state for staggered terms of six years and must be confirmed by the State Senate. No more than two may be from the same political party. The Department is free of partisan politics and is widely considered a model conservation agency. The Department is financed primarily from the sale of hunting and fishing permits and a 1/8 of 1 percent sales tax voted by the citizens of Missouri in 1976 to implement expanded conservation programs in the years ahead. The Department also receives federal aid funds from several agencies. Collectively, all funding sources support the broad-based programs of the Department, a state agency dedicated to public service and conservation.

As one of 14 departments of state government, the Conservation Department undergoes the same budgetary appropriation process and accounting and purchasing procedures as do other state agencies. Also the Department is audited by the State Auditor as requested in 1977 by the Conservation Commission.

The Department has divisions responsible for Fisheries, Forestry, Wildlife and Protection programs. Other organizational units are responsible for Conservation Education, Engineering, Fiscal, Public Affairs, Natural History, Operations, Outdoor Skills Education, Personnel and Planning functions.

Instructional Unit

ECOLOGY OF MISSOURI FORESTS

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Missouri Department of Conservation
Conservation Education Unit
Education Section

Conservation Education Series

Conservation education encompasses all the activities and experiences which result in learning about people's dependency upon and use of natural resources to satisfy their needs and wants. Since 1941, the Missouri Department of Conservation has supported a *formal education program* through Missouri's public and nonpublic schools. This formal education program is being expanded with the development of the *Conservation Education Series.* The series will include a number of instructional units designed to aid teachers in their efforts to integrate conservation concepts into appropriate junior and senior high school curricular areas.

The development of the *Conservation Education Series* is a formidable challenge involving many individuals. We are indebted to Director Larry R. Gale and Assistant Director Allen Brohn for their support and encouragement. We are also indebted to Donald K. Heard, Superintendent of Education, and Al Palladino, Assistant Superintendent of Conservation Education, for their guidance and assistance.

This series would not be possible without the contributions of each instructional unit's author and artist. Thanks to Elaine Callaway, Conservation Education Projects Coordinator, and Lisa Watt, Production Assistant, for their editing and production efforts.

The *Conservation Education Series* is dedicated to the Department's Conservation Education Consultants, past and present. This small group of men and women have recognized education as a vital and important force in resource conservation . . . and have accepted the challenge. The conservation challenge should concern all of us, but especially those charged with educating today's youth. We hope this series will aid Missouri teachers in meeting this challenge.

For additional information on conservation education programs, write the Education Section, Missouri Department of Conservation, P.O. Box 180, Jefferson City, MO 65102.

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How to Use this Instructional Unit

The *Ecology of Missouri Forests* Instructional Unit is designed to help science, social studies, vocational agriculture and other teachers incorporate forest ecology concepts into their subject matter.

This instructional unit describes the natural relationships within a forest—living as well as nonliving. Also included is an explanation of how nature restores a forest that has been destroyed, and a section on the major areas of tree growth and the key species particular to each area.

Basic Essential Skills Test (BEST) objectives covered in this unit are:

Reading/Language Arts #5, 12, 13, 14, 15, 16, 17, 21
Mathematics #1, 2, 3, 4, 6, 8, 9, 10, 11, 12, 14, 15
Government/Economics #7

Core Competencies and Key Skills addressed by this instructional unit are listed on pages 35 and 36.

Topic Outline

I. Introduction
- A. Forest communities
  1. History of Missouri forests
  2. Trees form natural associations
     a. Species composition
     b. Age class
     c. Density
  3. Environmental conditions affecting associations
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     b. Topography
     c. Drainage
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  5. Human benefits from forests
     a. Wood products
     b. Recreation
     c. Aesthetic value
- B. Objectives of unit

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  2. Temperature variation
- B. Woodland soil
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     b. Traps moisture
  3. Topography
  4. Soil types and drainage

III. Levels of deciduous forest
- A. Topmost level—canopy
  1. Dominant trees
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- B. Understory
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  2. Shade tolerant
- C. Woody shrubs
- D. Herbaceous plants
- E. Forest floor

IV. Age classes
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  1. Seedlings
  2. Saplings
  3. Pole sized

4. Small or large saw timber
5. Overmature

B. Density and composition

V. Food and energy relationships

A. Producers—green plants
1. Photosynthesis—carbon dioxide, soil moisture and sunlight
2. Produces sugar, cellulose and protein

B. Consumers
1. Herbivores
   a. Insects
   b. Chipmunks
   c. Squirrels
   d. Deer
   e. Turkeys
2. Carnivores
   a. Songbirds
   b. Hawks
   c. Hunters
3. Omnivores
   a. Robins
   b. Raccoons
4. Parasites
   a. Intestinal worms
   b. Leeches
   c. Ticks

C. Decomposers
1. Bacteria
2. Fungi
3. Earthworms
4. Snails
5. Millipedes
6. Insects

D. Food chains and webs

E. Energy
1. Converted to heat by body functions
2. No longer available to the ecosystem

F. Pyramid of life
1. Biomass
2. Numbers

G. Ecosystem diversity
1. Checks and balances
2. Disruption by non-native species
   a. European hare
   b. Gypsy moth

VI. Forest succession

A. Ecological succession
1. Gradual replacement of one community of plants and animals by another
2. Orderly and predictable sequence of events

B. Successional stages

(1) Post, blackjack, chinquapin and red oaks
(2) Dogwood, gum bumelia, Indian cherry, winged elm and red cedar

e. Tendency to remain open more than scattered as site conditions are unsuitable for tree growth

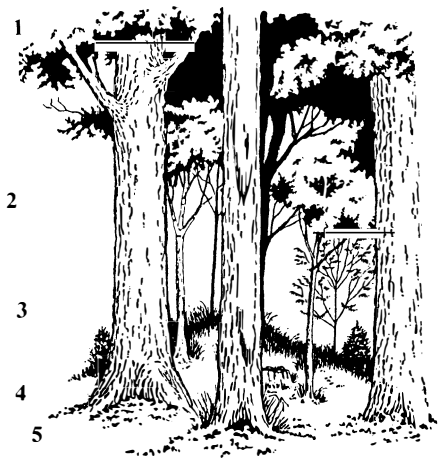
VIII. Summary

Introduction

Originally, forests covered nearly two-thirds of the State of Missouri, while the remaining area in the west and northwest was tallgrass prairie. Today, forest land covers less than one-third of the state, yet remains one of its major natural communities.

All forests are comprised of trees which form natural associations varying in species composition, age class and density. These associations are influenced by environmental conditions of climate, soil, topography, drainage, competition and human disturbances.

Forest Community Similarities



1. canopy
2. understory
3. shrubs
4. herbs
5. forest floor

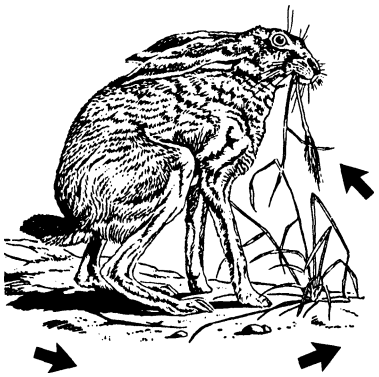
While individual forest communities differ according to region, all have many features in common. Despite the great diversity of plants and animals that make up a forest, the dominant plants are obviously trees. They form the top two vertical levels of plant growth, with many growing tall enough to form an overstory, or canopy. This upper level receives up to 90 percent of the available summer sunlight. The second level consists of understory trees that never grow tall enough to reach the canopy, as well as immature forms of the dominant trees.

Woody shrubs and herbs constitute the third and fourth vertical levels of forest growth. In addition, there is a fifth level of living organisms within the forest floor which consists mostly of decomposers.

All plant life in a forest is supported by typical woodland soil which is a product of the climate and of the vegetation that lives and dies there. The animals that make their home in the forest complete the life cycle by distributing nutrients and energy through food chains and food webs.

The forest is also essential to human life. A wide range of benefits, from the harvest of wood products to the appreciation of beauty, is available.

This instructional unit deals with forest ecology—the natural relationships that occur within a forest. The unit examines the nonliving influences of climate and soil in forest development, the dependence of plants and animals on soil for survival, and the soil's dependence on plants and animals for renewal. Also included is an explanation of the restoration process in a forest community that has been destroyed by human activity, and a section on the common tree associations found in Missouri forests.



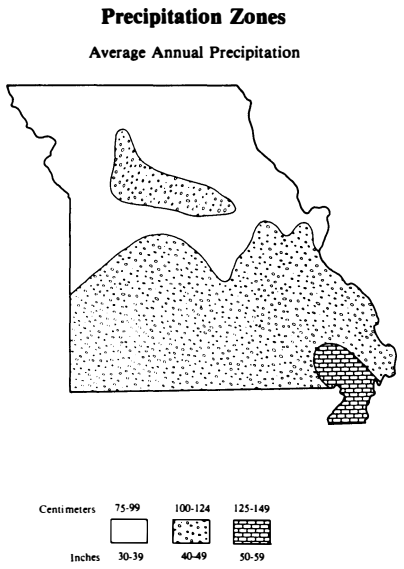
Soil

Objectives

The general objectives of this instructional unit are:

Each student should be able to:

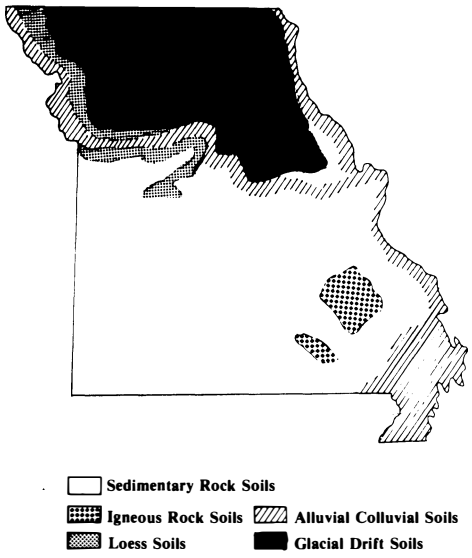
1. Explain how woodland soil results from the relationship between the local climate and the general types of organisms present.
2. Describe the five vertical levels that exist from top to bottom within a Missouri deciduous forest.
3. Define canopy, overstory, understory, shade tolerant, shade intolerant, deciduous.



4. List the environmental influences affecting how and where trees grow.
5. Explain how density and composition affect tree growth.
6. Name the five age classes of trees.
7. Define the following terms in relation to food and energy cycles within a typical forest: photosynthesis; producer; herbivore; carnivore; omnivore; parasite; decomposer; niche; biomass.
8. Outline the series of steps involved in the ecological succession of a Missouri forest after being cleared for agricultural purposes.
9. Name two major groups and a third general group of Missouri tree associations and tell where they are located.
10. Name the key tree species of each association.

Refer to individual lesson plans for more specific objectives.

Climate and Soils



The most important climatic requirement for forest growth is abundant precipitation. In Missouri precipitation averages about 30 inches (76 cm.) per year in the northwest corner to more than 50 inches (102 cm.) per year in the bootheel. Temperatures vary widely creating four distinct seasons, and precipitation is fairly well distributed throughout the seasons. It should be noted that northern and western parts of the state, originally covered by tallgrass prairie, were not really too dry for tree growth. Local woods had always existed in those regions, but trees were discouraged by the grazing activities of bison and elk, and by recurring fires started by lightning and Indians.

Just as plants must have soil in which to grow, the soil itself must continually be replenished by living organisms; neither is productive without the other. The mineral soil particles yield inorganic nutrients necessary for growth. The organic matter—remains of both plants and animals—provides recycled nutrients and a proper environment for roots to absorb needed air and water.

Missouri forest land is largely deciduous, meaning that the trees shed their foliage in advance of winter. Important exceptions are native evergreens which include eastern red cedar and shortleaf pine.

Woodland Soil Formation

A typical deciduous forest contributes up to three tons of fallen leaves, branches, logs and animal waste per acre per year. (Cedar and pine needles also form a carpet layer, though not as thick.) As this material decomposes, it creates a layer of humus on top of the mineral soil. The humus is then slowly mixed downward by the tunneling action of earthworms and other small, subterranean animals. This surface layer acts as a reservoir of fertility and protects soil which might otherwise be washed away during heavy rains. Except where reduced by fires and erosion, this surface layer serves as a sponge to trap moisture from rain and melting snows, and allows plant roots to absorb minerals present in the soil. This

layer also controls water runoff thus protecting the watershed and preventing silt pollution in local rivers and streams.

The topography of the forest floor affects the growth of some species of trees. Those species that grow on hilly land are influenced by the direction in which the slope tilts downward, often called *aspect*. Post oak and black hickory fare well on southwest-facing slopes exposed to the dry winds and direct sunlight of summer afternoons. Basswood and black walnut grow much better on cool, northeastern slopes that are sheltered from summer winds and receive less direct rays of sunlight.

Local Conditions

Local soil types and drainage are among the most important factors influencing which trees thrive on a particular site. For example, pin oak grows well on tightly packed, poorly drained soil, but the roots of shortleaf pine need loose, well-drained soil. Post oak is adapted to the thin, gravelly soil of Ozark ridges, but bur oak must have deeper soil that is relatively free of rocks.

Levels of a Deciduous Forest

A fully mature, or climax Missouri deciduous forest exhibits five vertical levels in much the same way that an office building might have as many floors. The levels are all part of the same living community, just as the five-story office building might serve a single company.

Overstory

The topmost level, or canopy, is made up of dominant trees such as oaks, hickories, ashes and black walnut. They are the tallest species and receive most of the sunlight, thereby shading other plants below. These species, which must have abundant sunlight, are shade intolerant.

Understory

The second level includes the understory trees. Some of these are acturally immature members of the dominant species; others are shade-tolerant species such as flowering dogwood, buckeye, hornbeam, and pawpaw.

Shrub Layer

The third level is composed of woody shrubs such as coral berry (buck brush), spicebush, bladdernut and witch hazel. It also includes infant trees of all species, many of which cannot survive to maturity because of competition for growing space and sunlight. There is also competition for other life-supporting needs. Any tree that must survive in deep shade also competes with others for soil nutrients and moisture.

Herbaceous Plants

The fourth level consists of ferns, wildflowers and other herbaceous plants that blossom in early spring before the leaves emerge on the trees above to shade out the sunlight.

Forest Floor

The final level is the forest floor itself, a carpet which is partly humus and partly living. It includes the remains of organisms and is the haven of fungi and small animals which serve as decomposers and recyclers of nutrients.

Age classes

Foresters have given standard names to the various sizes of trees within a forest. The youngest trees, up to about three feet tall (1 meter), are called seedlings while those up to four inches in diameter (10 cm.) regardless of height, are saplings. Larger trees, up to 1 foot (30 cm.) in diameter, are referred to as pole-sized. Understory trees seldom grow larger than this. Saw timber is a term used to describe forest trees larger than 1 foot in diameter. Any trees dying of old age are described as overmature, however, tree maturity is a biological function of site. Maturity or overmaturity is *not* an accurate classification of size or age.

Density and Composition

The number of trees in each age class depends upon various factors. Within a native *evergreen* forest most trees are similar in age and represent only one or two species, though competition results in trees of various sizes. In a *deciduous* woodland, such as those found in Missouri, there is usually a mixture of species and age classes. If a stand has previously been clearcut, however, the second growth will be of one age class for many years regardless of its species composition. As the stand grows, crowding and competition cause many young trees to die. This natural thinning process is most severe during sapling stage. Meanwhile, new shade-tolerant species establish themselves until finally, a diversity of age classes is once more developed.

Food and Energy Relationships

As in all natural communities, the green plants of a forest are its food producers. Using soil moisture plus carbon dioxide from the air, leaves manufacture sugars by the process of photosynthesis, which locks in the energy absorbed from sunlight. These sugars, along with small amounts of soil minerals, are then converted into other substances such as cellulose to make wood, and proteins for the growth of living cells.

Food producers, whether trees, shrubs or wildflowers, are then eaten by animals which are collectively called consumers. Included are immature and adult insects such as leaf-chewing caterpillars, wood-eating grubs and sap-sucking aphids. Also there are chipmunks, squirrels, deer, wild turkeys and songbirds that consume acorns, nuts and other seeds. The variety of these herbivores is almost endless. Any or all of these animals might then be eaten by carnivores or omnivores, and many may be the hosts of parasites. Examples of typical predatory animals include songbirds that consume caterpillars, hawks which feed on mice and squirrels, and the autumn hunter who bags a deer for home eating.

The omnivores, those animals that eat both plants and animals, are exemplified by the robin which eats berries and earthworms, and the raccoon that relishes corn as well as crayfish.

Parasites are more specialized, for they secure food from animals larger than they are without intending to kill their hosts. Common parasites include intestinal worms, leeches and ticks.

Every dead leaf, twig, branch, log and animal is also used as food. Bacteria, fungi, earthworms, snails, millipedes and insects break down these materials into usable soil nutrients available for plant growth, thus recycling nutrients through the ecosystem. In turn, the body proteins of these decomposers are available for consumption by soil predators such as moles, shrews and centipedes.

Every species within the community, according to its own needs, plays a special role which is called its *ecological niche.*

Food Chains

Each sequence, ranging from producer to top-level consumer to decomposer, represents a food chain that transfers energy originating from the sun. Many of these food chains, interconnected to show all the possible energy pathways, make up the community food web. A food "web," analogous to a spider web, is a fitting comparison to describe these complex energy relationships.

Matter and Energy

While energy is continually converted to heat by the processes of growth, respiration and the activities of moving animals, very little *matter* is lost unless it is in some way carried out of the forest. Decomposers recycle nutrients making them available for plant growth but the heat energy is lost to the atmosphere and is no longer available to the ecosystem.

Pyramid of Life

Since energy is converted to heat at each level of the food chain, there is more energy available for plant eaters than for predators. Stated simply, there is a pyramid effect from bottom to top in terms of numbers, biomass (total mass of living organisms) or both. As an example, hundreds of grass plants are needed to nourish a field mouse for a week, while many mice per week are needed to satisfy a red-tailed hawk. If the herbivorous link between grass and the same hawk happens to be rabbits, however, fewer rabbits might serve just as well as many more mice.

Balancing Populations

A natural community's diversity of species must be protected to maintain a healthy relationship of numbers and biomass. This variety serves as a system of checks and balances. We may not recognize the worth of some creatures, but every native species has some stabilizing influence. Termites, for example, are proven recyclers of dead wood in a forest, but they are undesirable in buildings.

The ongoing adjustment of a natural community's populations—a flexible balance—is also an important requirement for its

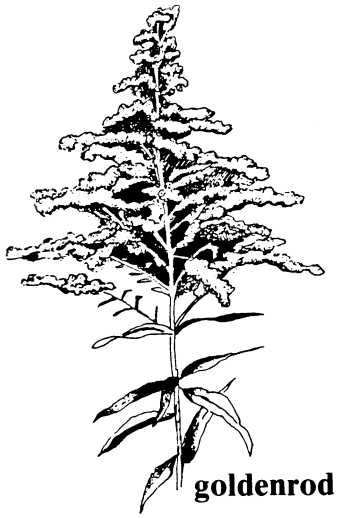
well being. If one type of herbivore grows too numerous due to a shortage of its controlling predators, it can severely damage the native plant life. This happened when the European hare was imported to Australia where no native predators existed to control its numbers. Such mistakes can occur anytime the importation of non-native animals is allowed.

Some years ago, the gypsy moth was accidentally introduced from Europe to New England. No indigenous insects or parasites were adapted to prey upon its leaf-consuming caterpillars. The gypsy moth has since spread westward until it now threatens Missouri forests. In the case of native insects that *temporarily* become too numerous, a natural enemy of the potential pest invariably brings it back under control. Often man's efforts to chemically control pests results in the destruction of biological control organisms.

Forest Succession

If the mature trees of a forest are removed by a logging operation they will be replaced by natural reproduction. However, if the forest has been destroyed by fire or other disturbances and the topsoil is lost to erosion, restoration will proceed only through a predictable series of changes known as *ecological succession.* A good example of this is when forest land has been cleared for agriculture, allowed to erode, and later abandoned.

Successional Stages



goldenrod

Once the woodland topsoil has eroded, annual weeds and grasses, which require little topsoil or shade, will become established in the remaining mineral soil. After two to five years, the dead portions of these pioneering plants generate enough organic soil for perennials to make their appearance. Perennial species, such as goldenrod, die back to their roots in autumn and resprout each spring. Within ten years the perennials are gradually replaced by woody shrubs such as coral berry and sumac. These species provide shade and improved soil for seedling trees to establish themselves. The initial trees are not the typical trees of the original forest. Instead of oaks, hickories, maples and black walnut, they are likely to be successional species such as cedar, elm, persimmon and sassafras. The original tree species will not return for perhaps another thirty years and by the time they mature, it will have been more than a hundred years since abandonment of the field. The forest then reaches a relatively stable, though dynamic condition and becomes a climax community, the end product of ecological succession. The full development of a climax forest takes longer than a human lifetime. Some areas, if too badly abused, take much longer to recover.

Missouri Tree Associations

Groups of trees dominating a particular forest community are known as *associations.* In Missouri, tree associations can be separated into two major groups—upland and floodplain. In addition, a third general group would include the associations that make

up woodland edges and successional forests. These associations and their subdivisions can best be recognized and appreciated by learning to identify the key tree species associated with each community.

Upland Forests

white oak

The most abundant and widespread forest type in Missouri is known as the oak-hickory association. It is dominated by various oaks and lesser numbers of hickories, with other kinds of trees also present. Key species are the white, post and red oaks, and the shagbark, mockernut and bitternut hickories. Among these will be a scattering of white ash, black walnut, sugar maple and basswood. Other species could also be listed for this association based on various site conditions such as soil type, drainage and slope direction. Throughout Missouri, the oak-hickory association can be found on varied locations such as dry ridges, gravelly slopes, and the deeper, well-drained soils of valleys.

A subdivision of the oak-hickory forest type covers large portions of the state's Ozark uplands. Here the basic association often includes sizable groves of shortleaf pine in addition to scarlet oak and black gum.

Floodplain Forests

shellbark hickory

The trees of river valley floodplains must be able to grow in alluvial soil and be adapted to having their roots covered with water for varying periods of time. Major species of this association in Missouri include bur oak, pin oak, shellbark hickory, pecan, sycamore, cottonwood, silver maple, black willow, green ash, hackberry and American elm. All of these can withstand temporary flooding during the growing season and even weeks of it during the winter dormant season. Nearly all of these trees can also grow on well-drained soil if it is deep enough, and are therefore not totally restricted to floodplains.

In the southeast Missouri bootheel region, floodplain trees can survive flooding for a longer period of time. Among the key species are overcup oak, willow oak, swamp chestnut oak and sweet gum. Two additional species, bald cypress and water tupelo, are uniquely adapted to year-round flooding; however, for successful reproduction they need an occasional growing season of drained soil for their seedlings to become established.

Woodland Edges

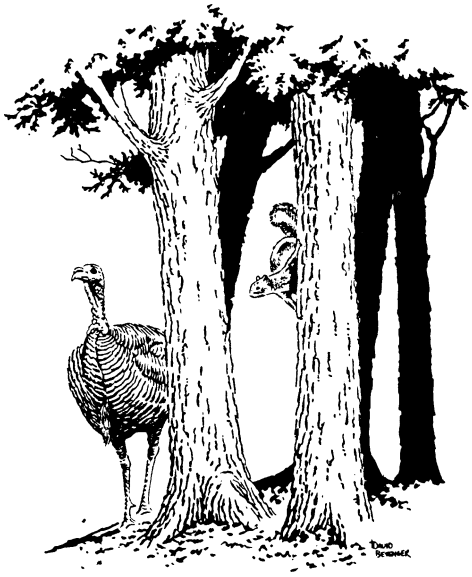
One might expect trees growing along the edges of cultivated fields and pastures to be the same as those of natural associations in adjoining forests, but since site conditions were altered by the original clearing of the land, other species tend to become invaders. Thus the edge of an oak-hickory forest might support such trees as red cedar, honey locust, elm, sassafras, black cherry, sycamore, cottonwood and other shade-intolerant species.

Glades

Where there is a natural edge between an open glade on rocky outcrops and neighboring woodland, a region of scattered, often stunted trees develop. This special glade condition is found throughout the Ozark portion of southern Missouri, where soils are

thin and bedrock occurs at the surface. Glades are most commonly found on south- and west-facing slopes where sunlight is most intense. Common trees and shrubs of glades include post, blackjack, chinquapin and red oaks, flowering dogwood, gum bumelia, Indian cherry, winged elm and red cedar. Glades are different from old fields, and tend to remain open with scattered trees rather than to change into a dense forest, since the site conditions of the glade are not well suited for tree growth.

Summary



The forest as a whole, whether it is a glade, floodplain, upland or woodland edge association, is greater than the sum of its parts. The plants and animals that make their home there, together with the climate and soil of the region, interact to form a life cycle that is essential to the existence of everything from the forest floor to the canopy.

But what nature tediously assembles, man can easily destroy. With the sweep of a bulldozer or the strike of a match, man can destroy in a matter of minutes what it took natural processes over 100 years to produce. Just as the organisms of the forest are dependent upon each other for survival, human life is dependent upon forest resources for current and future generations. A basic understanding of forest ecology is necessary to secure this future.

Lesson Plan No. 1

TITLE: Introduction to Forest Ecology

MATERIALS: Transparencies of Precipitation Zones (Appendix 1), and Forest Areas of Missouri (Appendix 2), Factors Influencing Tree Associations (Appendix 3), overhead projector and screen.

OBJECTIVES: After completing the lesson, the students should be able to:

1. Identify environmental and human influences which determine how and where trees grow.
2. Describe the components of typical woodland soil.
3. Describe how humus is formed and the purpose it serves.

METHOD: Lecture, discussion

PROCEDURE:

I. Introduction
   - A. What is a forest?
   - B. History of Missouri forests
     1. Originally two-thirds of Missouri was forested
     2. Currently one-third is forested—(see transparency)

II. Presentation
   - A. Factors influencing tree associations
     1. Climate
        - a. Trees need abundant precipitation (see transparency)
        - b. Temperature in Missouri produces four seasons
        - c. Missouri precipitation and temperature are adequate for tree growth
     2. Soil
        - a. Various tree species require different soil types and porosity
        - b. Site conditions determine species present
     3. Topography
        - a. Drainage—function of percent slope (steepness)
        - b. Aspect—direction of slope
          - (1) Direct or indirect sunlight
          - (2) Exposure to wind
     4. Human disturbances
        - a. Grazing by domestic animals
        - b. Fires
          - (1) Forest fires
          - (2) Prairie and field maintenance
        - c. Conversion to other uses
          - (1) Agriculture
          - (2) Urban expansion
          - (3) Other development

B. Woodland soil
   1. Components
      a. Inorganic nutrients—from parent material
      b. Organic materials
         (1) Humus
         (2) Leaves & twigs
         (3) Animals' remains
   2. Development
      a. Organic materials deposited
         (1) Deciduous components
         (2) Animals remains and wastes
      b. Decomposition produces humus
      c. Mixed downward by subterranean animals
   3. Value
      a. Reservoir of fertility
      b. Protects against erosion
      c. Absorbs and holds moisture

III. Summary
   A. Have students construct a woodland terrarium for classroom use.
      1. Soil components
      2. Plant components
   B. Point out that the terrarium shows only one level of a Missouri forest.

Lesson Plan No. 2

TITLE: Anatomy of a forest

MATERIALS: Transparency of Vertical Levels in a Deciduous Forest (Appendix 4), overhead projector and screen.

OBJECTIVES: After completing the lesson, the students should be able to:
1. Name and describe the five vertical levels of a deciduous forest including plant species particular to each level.
2. Name and describe the five age classes of trees.
3. Explain how density and composition affect tree growth.

METHOD: Lecture and discussion

PROCEDURE:

I. Introduction
   A. Woodland terrarium shows only one level of a forest.
   B. Trees are major forest plants.

II. Presentation
   A. Vertical levels of a deciduous forest (Transparency)
      1. Overstory—Canopy
         a. Shade-intolerant species
         b. Oaks, hickories, ashes, black walnuts

2. Understory
    a. Shade-tolerant (dogwood, buckeye, hornbeam & pawpaw)
    b. Immature dominants
3. Woody shrubs
    a. Coral berry (buck brush)
    b. Spicenut
    c. Bladdernut
    d. Witch hazel
4. Herbaceous plants
    a. Wildflowers
    b. Ferns
5. Forest floor
    a. Humus
    b. Decomposers

B. Tree sizes
1. Age classes
    a. Seedlings—up to 3 ft. (1 meter) tall
    b. Saplings—up to 4'' (10 cm.) diameter
    c. Pole-sized—4'' to 1 ft. (10-30 cm.) diameter
    d. Mature or saw timber—larger than 1 ft. (30 cm.) diameter
    e. Overmature—determined by site conditions, *not* by size
2. Composition
    a. Evergreen forest
        (1) Same age class
        (2) Different sizes
        (3) Same species
    b. Deciduous forest
        (1) Various age classes
        (2) Different sizes
        (3) Variety of species
3. Density and competition
    a. Sunlight
    b. Nutrients

III. Summary
A. Trees are dominant forest plants
B. Forest is more than trees

Lesson Plan No. 3

TITLE: Food and energy relationships

MATERIALS: Transparency of Pyramid of Life (Appendix 5), overhead projector, film: *More Than Trees* (MDC Film Loan), 16mm projector and screen.

OBJECTIVES: After completing the lesson, the students should be able to:
1. Describe the basic process of photosynthesis.
2. Define the following terms: producer; herbivore; carnivore; omnivore; parasite; niche; biomass.
3. List four stages of a woodland food chain.
4. Relate the importance of scavengers and decomposers to the forest ecosystem.
5. Describe the flow of matter and energy as depicted by the biotic pyramid.

METHOD: Lecture, discussion, film

PROCEDURE:

I. Introduction:
Point out that food and energy relationships in a forest are very complex

II. Presentation
- A. Forest food chain
  - 1. Producers—green plants
    - a. Photosynthesis uses carbon dioxide, soil moisture and sunlight.
    - b. Produces sugar, cellulose and proteins
  - 2. Consumers
    - a. Herbivores—insects, chipmunks, squirrels, deer, turkeys, etc.
    - b. Carnivores—songbirds, hawks, foxes, hunters, etc.
    - c. Omnivores—robins, raccoons, etc.
    - d. Parasites—intestinal worms, leeches, ticks, etc.
  - 3. Decomposers
    - a. Bacteria
    - b. Fungi
    - c. Snails
    - d. Millipedes
    - e. Insects
    - f. Scavengers
- B. Flow of matter and energy
  - 1. Energy
    - a. Converted to heat by body functions
    - b. No longer available to the ecosystem
  - 2. Matter
    - a. Nutrients recycled

b. Remains part of ecosystem

C. Pyramid of Life
   1. Biomass
   2. Numbers

D. Ecosystem diversity
   1. Checks and balances
   2. Disruption by non-native species

III. Summary
   A. Film: More Than Trees
   B. Have students find at least three library references on trees and forests. (poems, textbooks, essays, magazine articles, etc.)

Lesson Plan No. 4

TITLE: Forest Succession

MATERIALS: Transparencies of forest successional stages (Appendixes 6 to 10), overhead projector and screen

OBJECTIVES: After completing the lesson, the students should be able to:
1. Define *ecological succession.*
2. Identify the stages of ecological succession after a forest has been destroyed.
3. Name some of the major plant species involved in each stage of succession.

METHOD: Lecture, discussion

PROCEDURE:

I. Introduction
Discuss what is lost if a forest is destroyed.

II. Presentation
   A. Ecological succession
      1. Gradual naturally occurring replacement of one community of plants and animals by another
      2. Orderly and predictable sequence of events
   B. Forest destruction
      1. Forest fires
      2. Unmanaged harvest
      3. Conversion to other uses
         a. Agriculture
         b. Urban expansion
         c. Other development
   C. Successional stages
      1. Annual weeds and grasses
         a. Little topsoil
         b. Little shade
         c. Provide organic soil

2. Perennials (Transparency 7)
   a. Appear in two to five years
   b. Die in autumn; resprout in spring
   c. Goldenrod
3. Woody shrubs (Transparency 8)
   a. Appear in ten years
   b. Provide shade and improved soil
   c. Coral berry and sumac
4. Initial seedling trees (Transparency 9)
   a. Successional in nature
   b. Cedar, elm, persimmon, sassafras
5. Original tree species (Transparency 10)
   a. Appear 30 years after initial trees
   b. Climax condition

III. Summary
   A. Visit a forested area and/or abandoned field and note which successional stages are present. (See Lesson Plan #6)
   B. Divide the class into two groups; have one group take the position of conservationists who want to conserve Missouri forests. The other group will act as developers anxious to destroy forests to build schools, housing developments and factories. Have each group support its position and come to a reasonable solution to this dilemma.

Lesson Plan No. 5

TITLE: Missouri Tree Associations

MATERIALS: Transparency, Forest areas of Missouri (Appendix 2)

OBJECTIVES: After completing the lesson, the students should be able to:
1. Name the major forest types in Missouri and tell where they are located.
2. Name the major tree species of each forest type found in Missouri.

METHOD: Lecture and discussion

PROCEDURE:

I. Introduction
Missouri is on the western edge of the eastern deciduous forest biome and the eastern edge of the temperate grassland biome.

II. Presentation
   A. Upland forests
      1. Oak-hickory association
         a. White, post and red oaks
         b. Shagbark, mockernut & bitternut hickories

c. Other species
(1) White ash and black walnut
(2) Sugar maple and basswood

2. Locations
a. South-central and southeast-central Missouri
b. Statewide
(1) Dry ridges
(2) Gravelly slopes
(3) Well-drained valleys

3. Ozark upland subdivision
a. Same association as oak-hickory
b. Also includes shortleaf pine, black gum & scarlet oak

B. Floodplain forests
1. Characteristics
a. Alluvial soil
b. Subject to temporary flooding
c. Located statewide along rivers and streams

2. Major species
a. Cottonwood, sycamore, black willow, silver maple, pecan
b. Shellbark hickory, bur oak, pin oak, hackberry, American elm and green ash

3. Bootheel region
a. Subject to extensive flooding
(1) Overcup, willow, swamp chestnut oaks
(2) Sweet gum
b. Permanent flooding
(1) Bald cypress
(2) Water tupelo

C. Woodland edges
1. Field and pastures
a. Different from adjacent areas
b. Shade-intolerant species
(1) Red cedar, honey locust, elm
(2) Sassafras, black cherry, sycamore, cottonwood
c. May undergo successional changes to climax forest

2. Glades
a. Rocky outcrops
b. Ozark region
c. South- and west-facing slopes
d. Key species
(1) Post, blackjack, chinquapin and red oaks
(2) Dogwood, gum bumelia, Indian cherry, winged elm and red cedar
e. Tendency to remain open more than scattered as site conditions are unsuitable for tree growth

III. Summary
A. Forest is greater than the sum of its parts
B. Delicately balanced natural resource

Lesson Plan No. 6 (optional)

TITLE: Sampling a Forest: Random Pairs Method

MATERIALS: For each group: 100-foot measuring tapes (or 100 feet of clothes line rope marked in 25-foot segments); tree calipers (diameter tapes; basal area tapes); tape measures; tree identification guides; data tables.

OBJECTIVES: After completing the lesson, the students should be able to:
1. Collect data concerning tree populations in a woodland forest.
2. Identify common Missouri trees with the aid of a tree guide.
3. Analyze data collected in the field investigation.

METHOD: Outdoor investigation, field study

PROCEDURE:

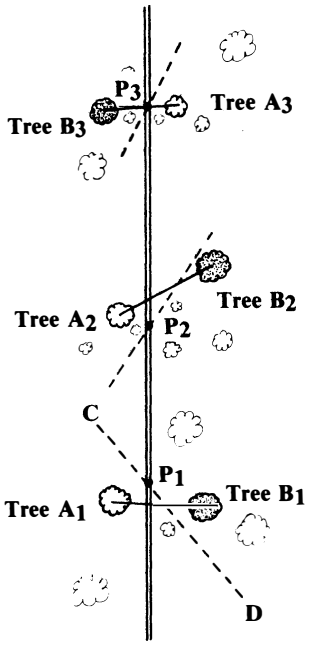
I. Introduction

The random pairs method is used to quickly sample communities in which the dominant plants are shrubs or trees such as in a woodlot or forest. The method uses paired tree samples selected at a number of points spaced along lines through a forest or woodlot. At least 50-100 pairs should be studied so have classes combine their data for the analysis. Calculations for relative density will not be reliable if less than 30 trees of a particular species are sampled. If less information is obtained there is still educational merit in having students complete the calculations and analysis.

II. Presentation

A. Teacher preparation

1. Divide the class into teams of three students each. Have each group select one member to be responsible for recording the data collected.
2. Determine the locations of the measuring tapes to be used for the study. Use a regular pattern consisting of a set of evenly spaced lines running parallel to the long axis of the woodlot. Space the measuring tape or ropes far enough apart and stagger them so that two adjacent groups will not sample the same trees.
3. Have each team of students proceed into the woodlot to the 25-foot mark on their assigned tape.



B. Student instructions
   1. Select the nearest tree to the point that is pole-sized or larger (tree A). Record its species and *dbh* (diameter, breast height—the diameter 4.5 feet from the ground) on your data sheet.
   2. Standing at Point 1 and facing tree A, raise your arms straight from your sides to make a 180° angle with the tree (line CD).
   3. Select the second tree of the pair from the area behind your arms. It will be the closest tree on the opposite side of CD from tree A (tree B). It must also be pole-sized or larger. Record its species and *dbh.*
   4. Measure the distance, *d,* between the center of tree A and the center of tree B.
   5. Continue to the next point (P_2 at the 50-foot mark) and repeat the entire procedure.
   6. Repeat the procedure at further points along your line until you have reached the end of your study area.
   7. Tabulate your data as shown on the data sheet.

C. Calculations
   1. Teacher
      a. Combine data from all teams to increase the reliability of the following calculations.
      b. Since no measurements of area are made in this method, the calculation of density and dominance (cover) must be done indirectly. If the facilities are available you may wish to have calculations programmed into a computer.
      c. You may wish to assign each team a particular species for calculations (e-i) and combine data in tables A & B.

   2. Students
      a. Calculate the average distance between all trees. (Total distances divided by number of points.) Multiply this answer by a correction factor of 0.8 (research indicates this provides a more accurate estimate of the average distance.)
      b. Square the "corrected" average distance (d) to determine the average area occupied by a tree (d^2).
      c. Divide the average area occupied by a tree (d^2) into the unit area in which you want density expressed. This gives the total density of all species (number of trees per unit area, regardless of species). If distances were measured in meters the unit area may be hectares 10,000 m^2.

$$\text{total density of all species} = \frac{10{,}000\ m^2}{d^2}$$

d. Foresters commonly express density as number of trees per acre. Since there are 43,560 ft.^{2} in an acre, the following formula can be used to calculate the average number of trees per acre (*d* must be measured in feet):

$$\text{total density (trees per acre)} = \frac{43{,}560\ ft.^2}{d^2}$$

(Smaller unit areas may be used to make numbers more manageable.)

e. Determine the number of individuals of each species of tree.

f. Using the *dbh* values calculate the basal areas for all of the trees of each species ($A = \pi r^2$).

g. Total the basal areas for each species. Divide by the number of individuals of the species to obtain an average cover for the species.

$$\text{average cover for a species} = \frac{\text{total basal area for the species}}{\text{total number of individuals of the species}}$$

h. Summarize your calculations in Table A.

i. Use the original data and the information in A to calculate the following: (Record your information in Table B.)

$$\text{frequency} = \frac{\text{number of points at which a species occurs}}{\text{total number of points}}$$

$$\text{relative frequency} = \frac{\text{frequency of a species}}{\text{total frequency of all species}} \times 100$$

$$\text{relative density} = \frac{\text{number of individuals of a species}}{\text{total number of individuals of all species}} \times 100$$

$$\text{density} = \frac{\text{relative density of a species}}{100} \times \text{total density of all species}$$

$$\text{cover} = \text{density of a species} \times \text{average cover for the species}$$

$$\text{relative cover} = \frac{\text{cover for a species}}{\text{total cover for all species}} \times 100$$

importance value = relative frequency + relative density + relative cover

III. Summary

A. Discussion questions

1. Write a description of the tree populations in the forest area investigated.
2. According to the data, which trees are the dominant ones?
3. How would the data be changed if an orchard had been investigated?
4. What are the advantages/disadvantages of the "random pairs" method of investigating a community?
5. What other items could be sampled using this method?

B. For a more detailed analysis have students conduct a point-quadrant, line transect or quadrant analysis of the forest vegetation.

DATA SHEET

Point	Tree A		Tree B		Distance (d) between A and B
	Species	*dbh*	Species	*dbh*	
P_1					
P_2					
P_3					
P_4					

Table A

Species	# of individuals	average cover

Table B

Student Handout

Species of Tree	Frequency	Relative Frequency	Relative Density	Density	Cover	Relative Cover	Importance Value

Glossary

annual plant: one that does not live beyond the first growing season; survives only as seeds.

aspect: the direction in which the slope of the land tilts downward.

associations: groups of trees, such as oaks and hickories, which dominate a particular forest community.

basal area: (forestry) area of a cross section at breast height of a single tree or of all trees in a stand.

biomass: total mass, or weight, of particular organisms, representing one level of a food web.

climax forest: the type of mature forest as determined by the local climate.

deciduous: trees or shrubs which lose their foliage during winter.

decomposer: plant or animal feeding on dead organisms to aid in recycling their nutrients.

density: the number of individuals per unit of space; a measure of crowdedness.

dominant plants: any plants which dominate the vegetation within a natural community.

dominant trees: trees that grow tall enough to dominate or overshadow, all other plant life.

ecology: the study of relationships among living things and their environment.

evergreen: trees and shrubs which keep their foliage throughout the year.

food chain: a series of living organisms, always beginning with green plants, which feed upon each other.

food web: a group of food chains which have interconnecting links within the same community.

forest succession: a series of predictable changes in plant populations through which a disturbed forest community reverts back to its original condition.

glade: a natural clearing surrounded by woodland, usually caused by site conditions not suitable for trees.

herbaceous: refers to annual and perennial plants which have no woody tissue.

humus: partially decayed remains of plants and animals lying on top of or mixed into topsoil.

inorganic nutrients: usable life-supporting minerals derived mostly from rock.

leaching: the action of soil water percolating downward to remove available mineral nutrients.

mature trees: in terms of forest dominants, those larger than the pole-sized age class.

niche: the role played by a particular animal within its own biological community.

omnivore: any animal which eats food of both plant and animal origin.

organic nutrients: usable life-supporting substances derived from either living or dead organisms.

overmature trees: forest dominants which are slowly dying of natural causes.

parasite: any organism which normally feeds on another larger than itself without actually killing its hosts.

perennial plant: a plant that dies back each autumn to resprout from the same roots in the spring.

photosynthesis: process by which green plants manufacture sugar with the energy derived from sunlight.

pole-sized trees: emerging forest dominants larger than sapling but no larger than 12 inches in diameter.

predator: any animal that kills another for food; topmost link of a food chain.

producer: any green, food-manufacturing plant which forms the bottom link of a food chain.

sapling trees: immature trees larger than seedlings but not more than 4 inches in diameter.

second growth: stands of forest trees which develop after the original growth has once been logged off.

seedling trees: the youngest trees, up to about three feet tall.

shade-intolerant trees: those trees which cannot survive under the shade of other trees.

shade-tolerant trees: trees which can grow and thrive under the shade of other trees.

site conditions: specific factors such as soil, drainage, and slope, influencing tree growth at a particular location.

slope direction: general compass direction in which a hillside slopes downward.

species composition: the combination of tree species growing in an association.

subterranean: anything beneath the earth's surface.

successional trees: those which grow first in a developing forest, later to be replaced by a more permanent tree association.

vegetarian: any animal which feeds entirely on plant material; the middle link of a food chain.

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Platt, Rutherford. *The Great American Forest.* Prentice-Hall, 1965.

Settergren, Carl and McDermott, R. E. *Trees of Missouri.* Booklet available from the University of Missouri Agriculture Extension Service.

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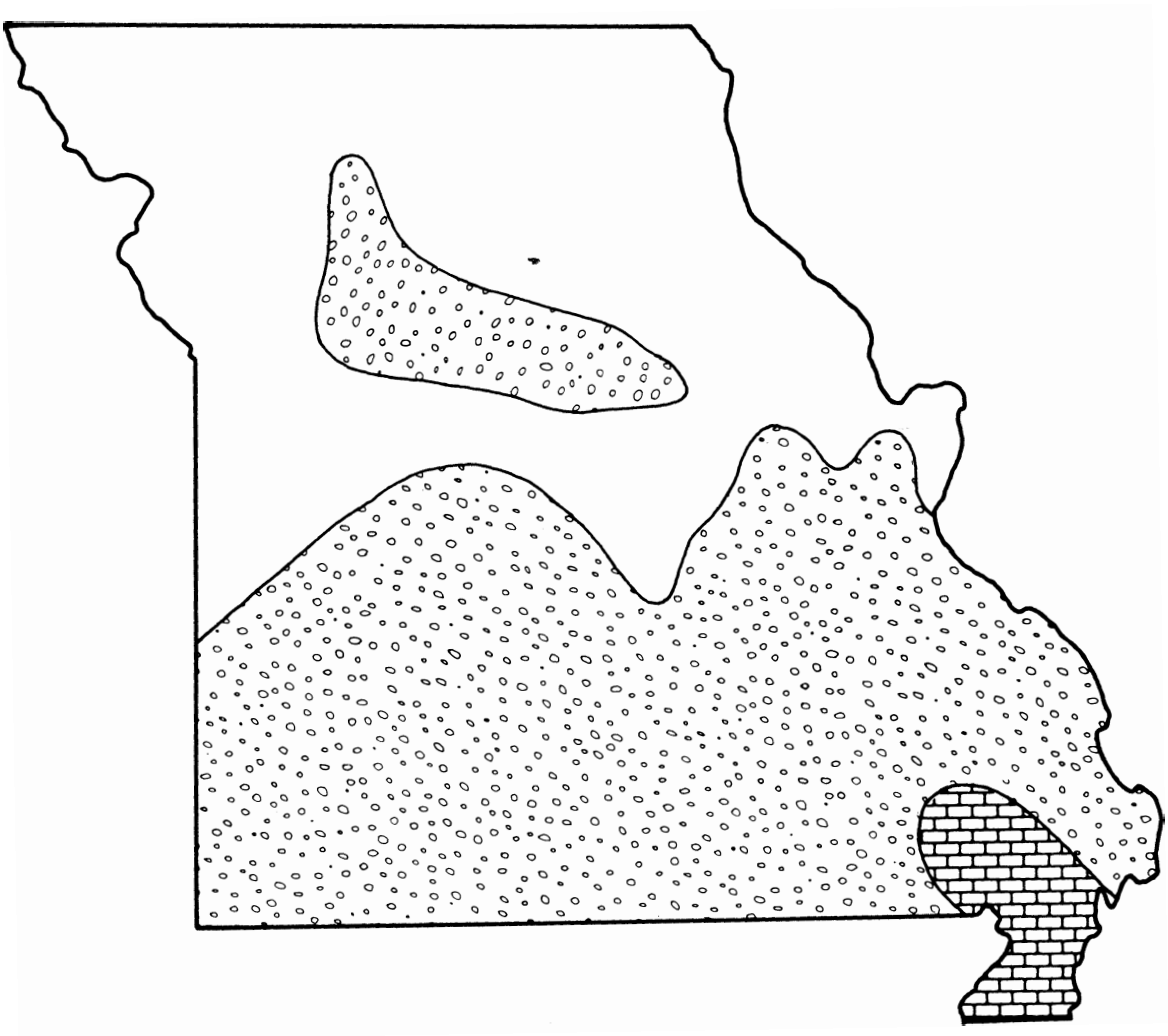
Precipitation Zones

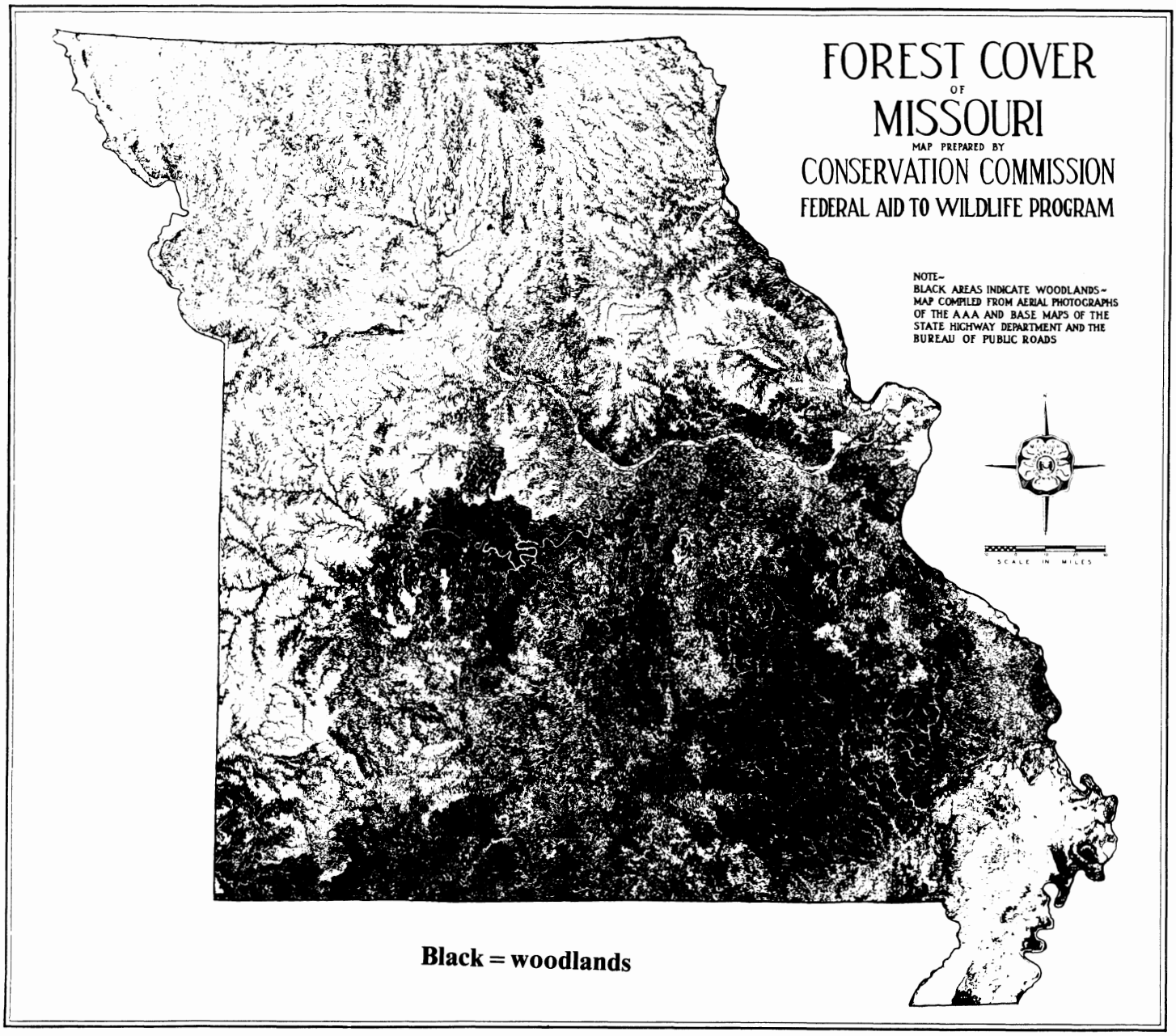
Average Annual Precipitation



Centimeters	75-99	100-124	125-149
Inches	30-39	40-49	50-59

Appendix 2—Transparency

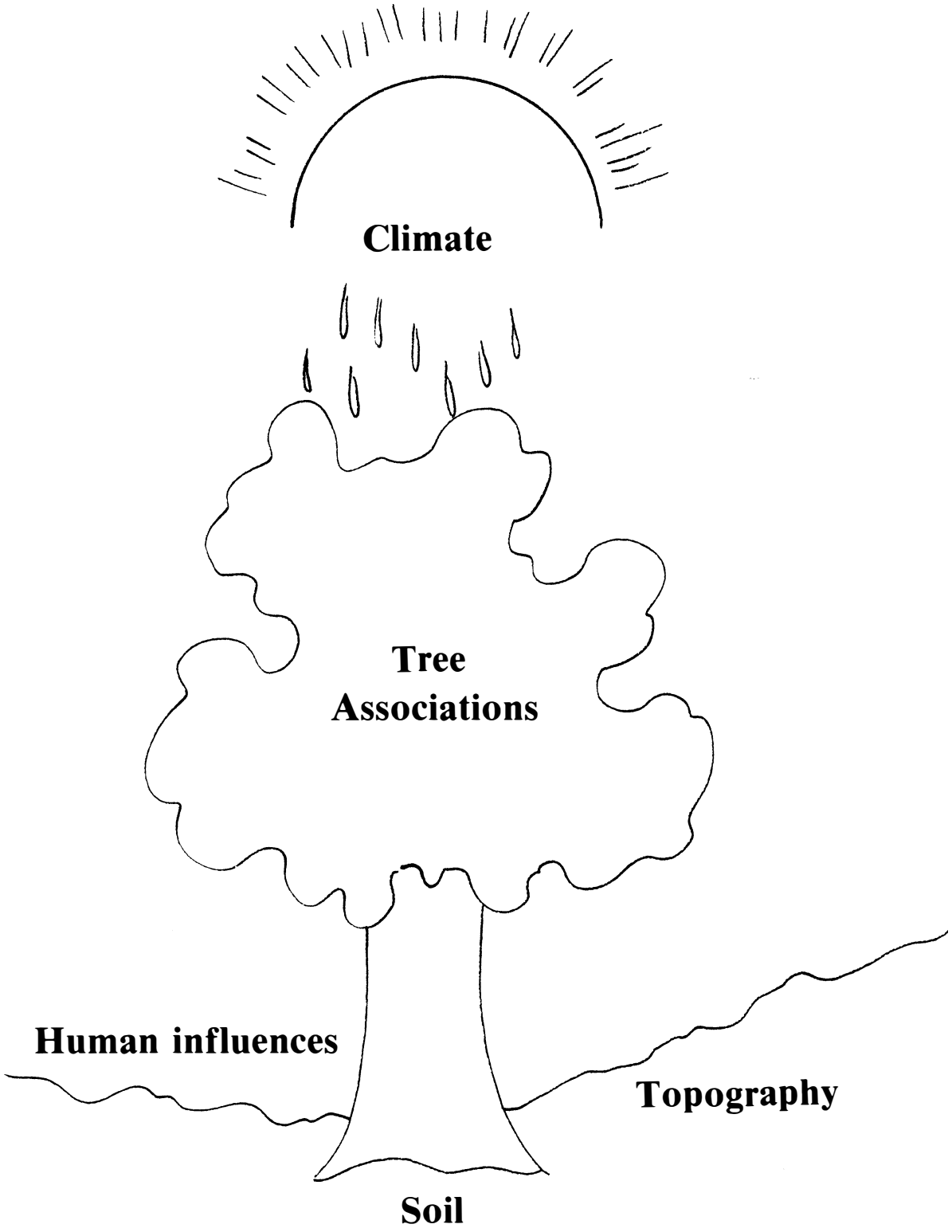
Forest Cover of Missouri



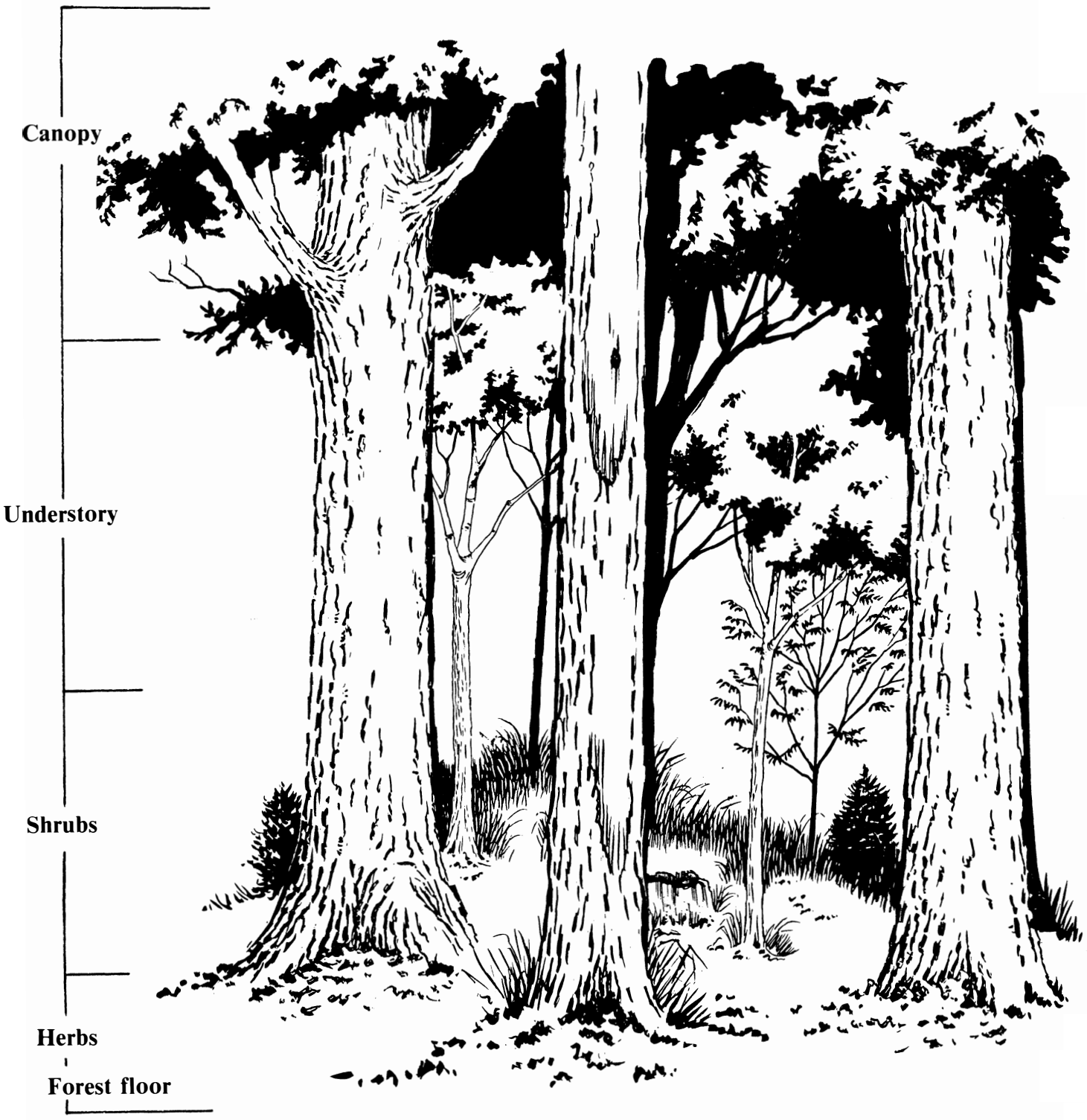
Black = woodlands

Appendix 3—Transparency

Factors Influencing Tree Associations

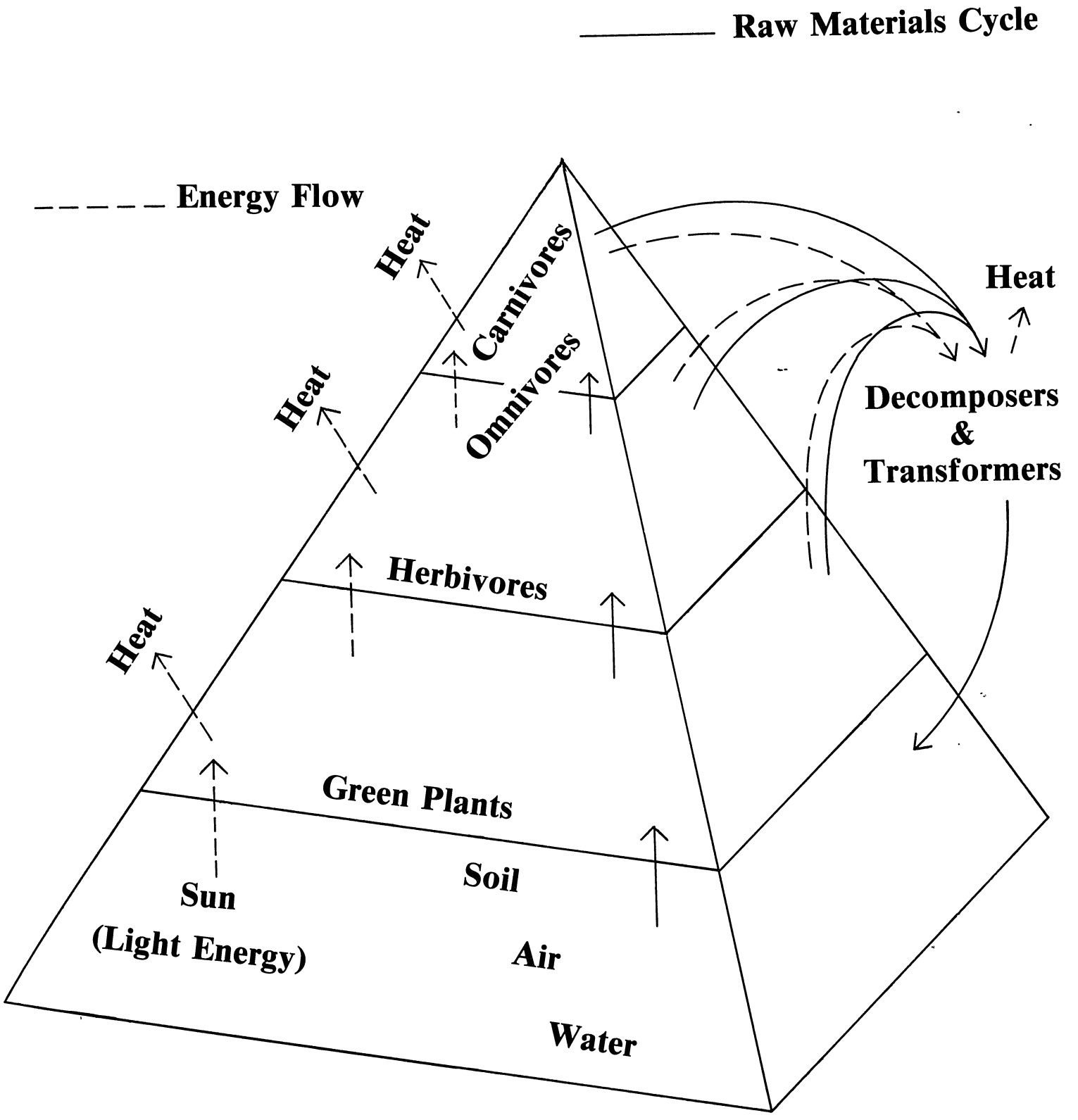


Vertical Levels in a Deciduous Forest



Appendix 5—Transparency

Pyramid of Life

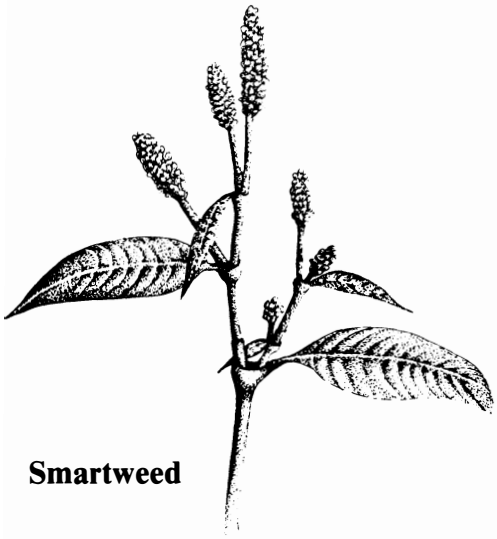


Forest Succession

Annual Weeds and Grasses

Bracted Plantain
Crotons
Dropseed
Foxtail
Lespedeza
Panicum
Partridge Pea
Pigweed
Poverty Grass
Ragweed
Smartweed
Tick Trefoil
Trailing Bean

Beggar's Ticks



Smartweed

Foxtail

Coyote
Dove
Grasshopper
Horned Lark
Killdeer
Meadow Lark
Mice
Quail
Rabbit
Rodents

Forest Succession

Perennials

Annuals
Asters
Bedstraw
Bluegrass
Bluestem
Bull Nettle
Clovers
Dropseed
Goldenrod
Indian Grass
Lespedeza
Panicum
Sedge

Bluestems
Broom Sedge
Buttonweed
Cinquefoil
Coneflower
Dewberry
Dropseed
Hop Clover
Ironweed
Lead Plant
Milkweed
Morning Glory
Primrose

Rosa sp.
Spurge
Switchgrass
Wild Indigo

Coneflower

Milkweed

Clover

Black Snake
Coyote
Dickcissel
Dove
Field Sparrow
Fox
Horned Lark
Jack Rabbit
Marsh Hawk
Meadow Lark
Pheasant
Prairie Chicken
Quail
Rabbit
Rodents
Skunk
Woodchuck
Yellow-throat

Badger
Black Snake
Coyote
Dickcissel
Dove
Field Sparrow
Fox
Gopher Frog
Grasshoppers
Ground Squirrel
Horned Lark

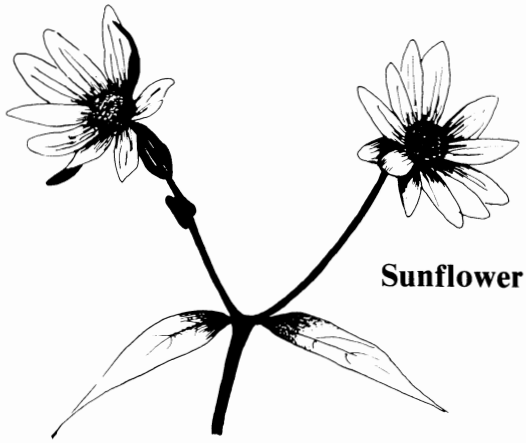
Jack Rabbit
Marsh Hawk
Meadow Lark
Pheasant
Prairie Chicken
Quail
Rabbit
Rodents
Skunk
Woodchuck
Yellow-throat

Appendix 8—Transparency

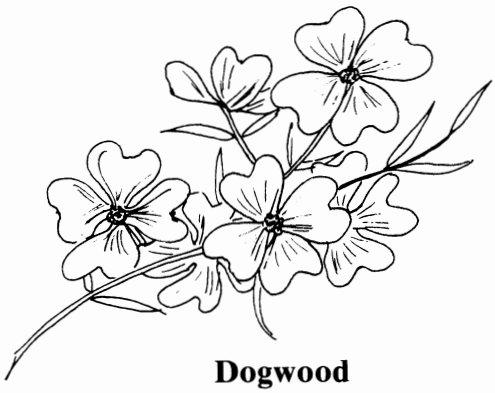
Forest Succession

Woody Shrubs

Aster
Bergamot
Bittersweet
Blackberry
Bluegrass
Bluestem
Coral berry
Cord Grass
Dogbane
Dogwood
Elderberry
Fleabane
Grape
Hazel
Indian Grass
Joe Pye Weed
Lead Plant
Needle Grass
Poison Ivy
Prickly Ash
Rosa sp.
St. John's-Wort
Sumac
Sunflower
Viburnums
Wild Indigo



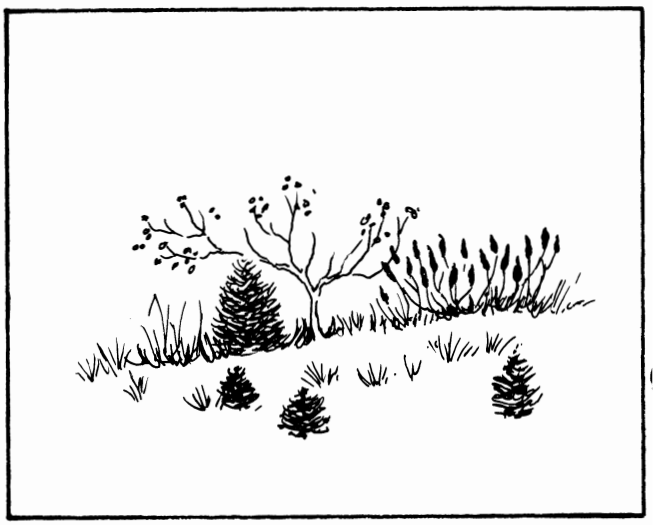
Sunflower



Dogwood

Leadplant

Assassin Bug
Black Snake
Bluejay
Cardinal
Catbird
Chat
Chipping Sparrow
Coyote
Damsel Bug
Dickcissel
Dove
Field Sparrow
Fox
Garter Snake
Goldfinch
Ground Squirrel
Horned Lark
Indigo Bunting
Jack Rabbit
King Snake
Marsh Hawk
Meadow Lark
Mocking Bird
Pheasant
Prairie Chicken
Quail
Rabbit
Rodents
Short Eared Owl
Skunk
Towhee
Upland Sandpiper
Woodcock
Woodchuck
Yellow-throat



Appendix 9—Transparency

Forest Succession

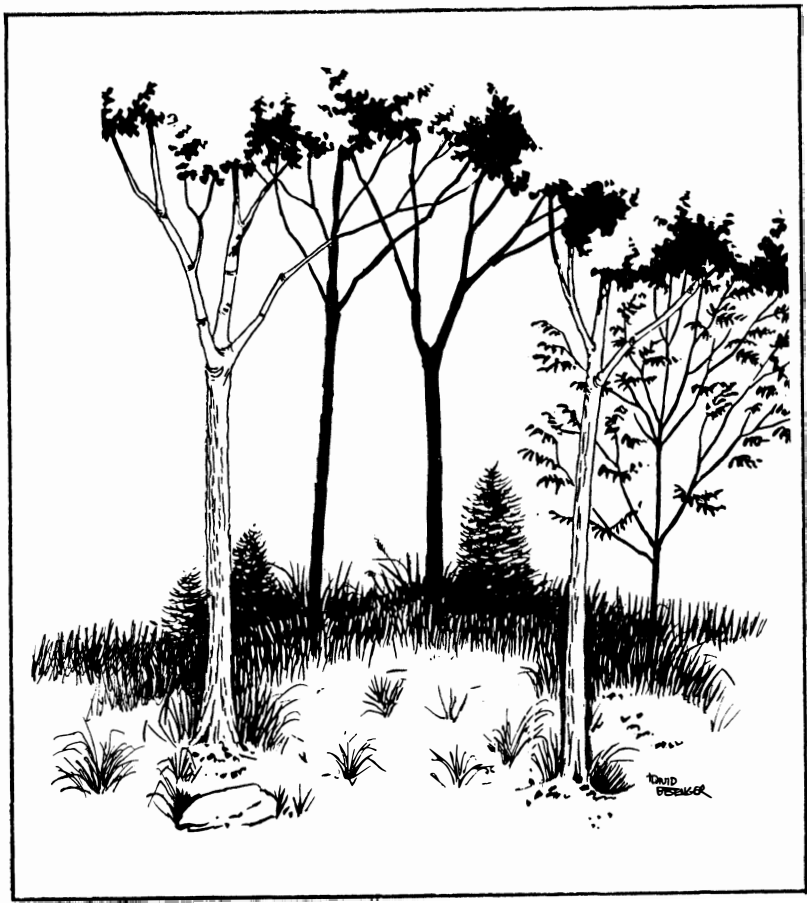
Initial Seedling Trees

American Elm
Bitternut Hickory
Black Jack Oak
Bumelia
Cherry
Hackberry
Hawthorn
Honey Locust
Locust
Mockernut Hickory
Osage Orange
Persimmon
Post Oak
Plum
Red Cedar
Redbud
River Birch
Sassafras
Shagbark
Shortleaf Pine
Slippery Elm
Smilax
Soft Maple
Sycamore
Walnut
White-Green Ash
Willow

Black Locust

Redbud

Red Cedar



Bluejay
Brown Thrasher
Cardinal
Chipping Sparrow
Fox
Fox Sparrow
Mink
Opossum
Quail
Rabbit
Rodents
Ruffed Grouse
Skunk
Squirrels
Towhee
Tree Sparrow
Woodcock
Woodchuck

Appendix 10—Transparency

Forest Succession

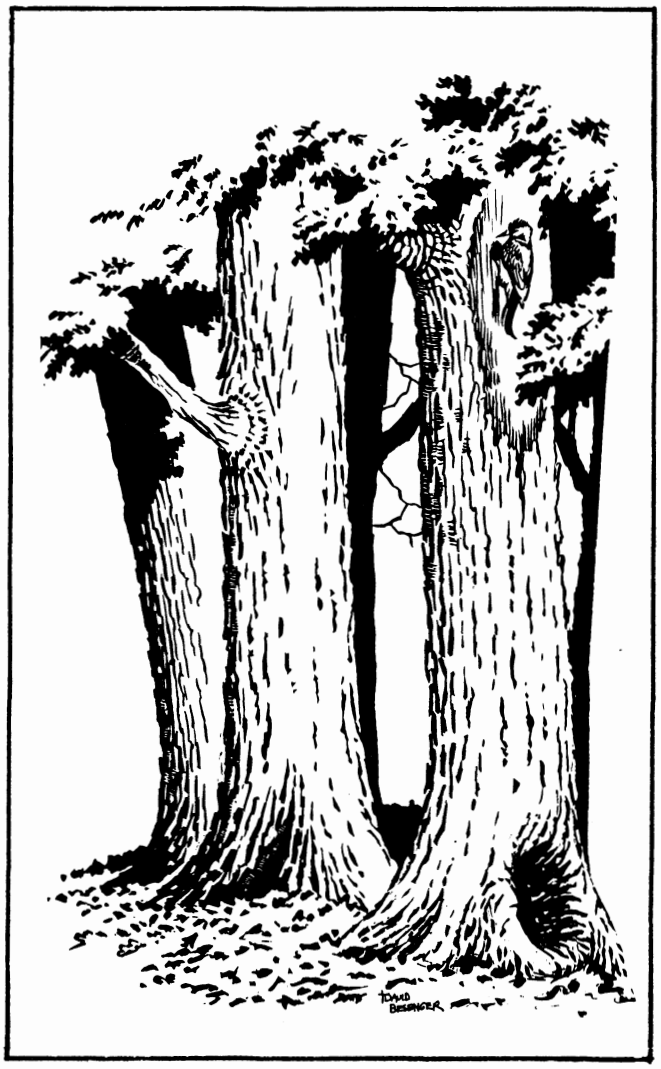
Original Tree Species

Basswood
Beech
Black Oak
Buckeye
Chinquapin Oak
Dogwood
Ironwood
Magnolia
Pignut Hickory
Red Maple
Red Oak
Redbud
Scarlet Oak
Shagbark Hickory
Shingle Oak
Sugar Maple
Sugarberry
Tulip
White Ash
White Oak

Red Maple

Ozark Chinquapin

Shagbark Hickory



Bear
Chipmunk
Crows
Cuckoo
Deer
Flycatchers
Gray Fox
Nuthatches
Opossum
Owls
Raccoon
Red-eye Vireo
Ruffed Grouse
Squirrels
Turkey
Warblers
Weasel
Wood Thrush
Woodpeckers

Appendix 11

Core Competencies and Key Skills Addressed in *Ecology of Missouri Forests*

LEVEL VII

Language Arts/Reading/English

Reading: A-1, A-2, B-1, C-5, C-8, C-10, D-1, D-2, D-4, Dk-5, D-7
Writing: F-2, G-13
Listening/Speaking: H-1, J-2, K-2, K-4

Mathematics

Mathematics: A-5, B-1, B-9, C-2, G-3, G-5

Science

Science: A-6, B-1, D-9, H-3, H-4

Social Studies/Civics

Government (Civics): K-1, L-1, L-2
Other Social Studies Competencies: V-1, V-2, V-3

LEVEL VIII

Language Arts/Reading/English

Reading: A, B-1, C-4, C-7, C-9, D-1, D-2, D-3, D-4, D-6
Writing: F-2, G-12
Listening/Speaking: H-1, J-2, K-2, K-4

Mathematics

Mathematics: B-1, C-3

Science

Science: B-1, C-5, E-1, F-5, H-1

Social Studies/Civics

Government (Civics): K-1, L-3
Other Social Studies Competencies: V-1, V-2, V-4

LEVEL IX

Language Arts/Reading/English

Reading: A, B-1, C-9, C-11, D-1, D-2, D-3, D-4, D-7, D-9
Writing: F-3
Listening/Speaking: H-1, J-1, J-5, K-1, K-3

Mathematics

Mathematics: A-1, B-3, C-3, F-2, F-3

Science

Science: D-9

Social Studies/Civics

Government (Civics): L-1
Other Social Studies Competencies: V-1, V-4

LEVEL X

Language Arts/Reading/English

Reading: A, B-1, C-4, D-1, D-2, D-3, D-4, D-7, D-9
Writing: F-3
Listening/Speaking: H-1, J-1, J-5, K-1, K-3

Mathematics

Mathematics: A-1, F-2

Science

Science: A-2, C-5, D-4, J-2

Social Studies/Civics

Geography: B-2
Other Social Studies Competencies: V-2

Appendix 12

BEST Objectives Covered by this Instructional Unit

Reading/Language Arts

5. Use reference materials and sources to obtain information to solve personal problems.
12. Follow a set of written directions.
13. Interpret information presented in graphic or pictorial manner.
14. Speak and write effectively in different social and business situations and with persons of varied ages or backgrounds.
15. Write with complete sentences, acceptable sentence structure, acceptable grammatical construction, and correct spelling and punctuation.
16. Use reference materials and sources (including human sources) to obtain information to solve personal problems.
17. Recognize the main idea and specific details in an oral presentation.
21. Follow oral or written directions to complete a process.

Mathematics

1. Add and subtract whole numbers in sample problems involving real-life situations.
2. Multiply and divide whole numbers in sample problems involving real-life situations.
3. Add and subtract common and decimal fractions in sample problems involving real-life situations.
4. Multiply and divide common and decimal fractions in sample problems involving real-life situations.
6. Solve problems involving measure of length, area, and volume.
8. Interpret information from charts, graphs, tables, maps, and scale drawings.
9. Solve sample problems by applying the concept of ratio and proportion.
10. Interpret simple probability and statistical statements relating to common situations such as weather reports and opinion polls.
11. Determine the average for given numerical data.
12. Identify horizontal, vertical, parallel, and intersecting lines.
14. Use standard measuring devices to measure length, area, volume, weight, time, and temperature in common English and metric units.
15. Estimate results and judge the reasonableness of answers to computational problems.

Government/Economics

7. Understand basic factors related to the production of goods and services.

Ecology of Missouri Forests

Test Questions

Circle the letter of the correct answer:

T F 1. Biology is the study of relationships between living things and their environment.

T F 2. The role an animal plays in its natural community is its habitat.

T F 3. The tallest trees in a forest make up the canopy.

T F 4. Plants which must have abundant sunlight to grow are called shade tolerant.

T F 5. Deciduous trees shed their leaves before winter.

MULTIPLE CHOICE

6. What fraction of Missouri is now covered by forest land?
   (a) one-fourth (b) one-third (c) one-half (d) two-thirds

7. A native evergreen tree typical of eastern Ozark ridges is the:
   (a) shortleaf pine (b) scotch pine (c) bur oak (d) white pine

8. The inorganic nutrients of a woodland soil come mostly from:
   (a) decayed plants (b) the leaching out of rain (c) soil particles
   (d) the recycling of humus

9. Which one of the following is not a function of humus in woodland soil?
   (a) holds moisture (b) captures energy from the sun
   (c) helps prevent soil erosion (d) contributes organic nutrients

10. Termites within a rotting log are examples of:
    (a) decomposers (b) omnivores (c) predators (d) parasites

11. The process of photosynthesis takes what substance from the air?
    (a) energy (b) carbon dioxide (c) water (d) oxygen

12. Which is not a photosynthetic producer?
    (a) fern (b) pine tree (c) mushroom (d) poison ivy vine

13. The energy in a typical food chain:
    (a) is increased as more food is eaten
    (b) is largely used up by life activities
    (c) is finally converted to soil humus
    (d) goes back to its origin in the sun

14. A sapling is a tree
    (a) shorter than three feet tall
    (b) less than 4 inches in diameter but taller than three feet
    (c) big enough to have sap in its trunk
    (d) larger than 4 inches in diameter

15. Which tree is a key species in a Missouri floodplain association?
    (a) sycamore (b) post oak (c) red cedar (d) black hickory

Match the key species with the Forest Association:

16. ____ Ozark Upland subdivision
17. ____ Floodplain
18. ____ Bootheel
19. ____ Upland forest
20. ____ Woodland Edge

A. red oak, white oak, shagbark hickory
B. cottonwood, sycamore, black willow
C. bald cypress, water tupelo
D. sassafras, red cedar, persimmon
E. white oak, mockernut hickory, shortleaf pine

MATCHING ITEMS

21. ____ herbivore
22. ____ omnivore
23. ____ biomass
24. ____ parasite
25. ____ humus
26. ____ producer
27. ____ carnivore
28. ____ overstory
29. ____ shade-tolerant

A. total mass of living organisms
B. animal which feeds on animals larger than itself without intending to kill its host
C. green plant which is capable of photosynthesis
D. organic matter for the soil
E. eats plants and animals
F. animal that eats plants exclusively
G. animal which eats other animals
H. top level or canopy of a forest
I. trees and shrubs occurring in the understory of a forest

AGE CLASSES: Write the age classification of the following trees.
Pole-sized, saw lumber, sapling, seedlings, overmature

30. _____ white pine that is 11 inches in diameter
31. _____ sweet gum 2 feet tall
32. _____ large black walnut dying of old age
33. _____ shagbark hickory 2 feet in diameter
34. _____ shortleaf pine 3 inches in diameter
35. _____ cottonwood 8 inches in diameter
36. _____ white oak 15 inches in diameter

37. Place the following stages of ecological succession in order from abandoned farmland to climax deciduous forest.

____ dominant tree species

____ perennial grasses

____ annual weeds and grasses

____ woody shrubs

____ successional tree species

38. Name three environmental factors which determine the plant associations in a forest.

39. Name the five vertical levels of a forest and give examples of the plants or materials found at each level.

40. How do matter and energy differ in their flow through the forest ecosystem?

41. Write a complete food chain found in a forest ecosystem

Ecology of Missouri Forests

Answer Key

1. F
2. F
3. T
4. F
5. T
6. b
7. a
8. c
9. b
10. a
11. b
12. c
13. c
14. b
15. a
16. E
17. B
18. C
19. A
20. D
21. F
22. E
23. A
24. B
25. D
26. C
27. G
28. H
29. I
30. pole-sized
31. seedling
32. overmature
33. saw lumber
34. sapling
35. pole-sized
36. saw lumber
37. 5
    2
    1
    3
    4
38. climate, topography, soil
39. a. overstory or canopy—tallest trees, shade-intolerant, dominant species: oaks, hickories, etc.
    b. understory—immature dominants, shade- tolerant species, dogwood, buckeye, paw-paw, etc.
    c. woody shrubs—shrubs and infant trees, coral berry (buck brush), spicenut, bladdernut, witch hazel
    d. herbs—wildflower, ferns, mosses
    e. forest floor—humus layer, leaf litter, rotting logs, decomposers
40. Matter is recycled into soil nutrients but energy is converted to heat and leaves the ecosystem.
41. Chain should include—producer, herbivore, carnivore (or omnivore) and decomposer.

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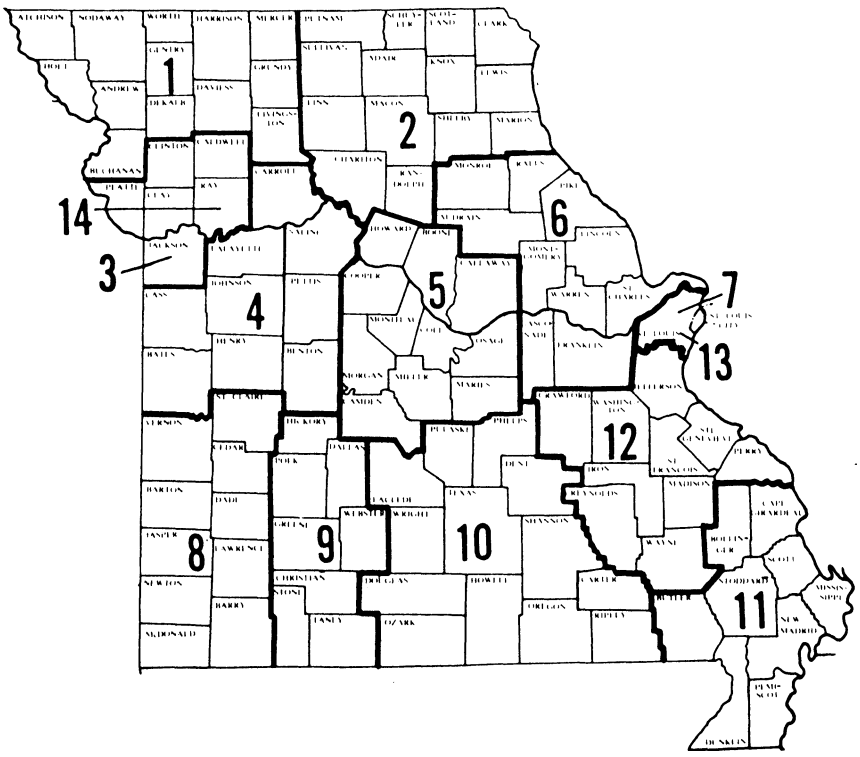
Conservation Education Consultants are available to provide conservation education assistance and offer courses and workshops in conservation.



Outdoor skills education specialists will assist you in obtaining materials and scheduling equipment and films that are available from the Department of Conservation. They also offer workshops to provide training in outdoor skills education. For the name and address of the outdoor skills education specialist serving your area, contact:

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NOTES: